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Remarks

Reconsideration and allowance of the subject patent application are respectfully requested.

The office action dated September 11, 2003 did not forward initialed PTO-1449 forms to evidence the Examiner's consideration of the documents submitted with the Information Disclosure Statements filed on September 10, 2003 and July 25, 2003. Applicants respectfully request that initialed forms be returned with the next office action.

Claim 4 has been amended to remove a redundancy with respect to claim 1.

The illustrative example embodiments described in the present application show a semiconductor device in which a metal layer is provided in an opening formed in an insulating layer that exposes a conductor. The metal layer covers the exposed conductor, but not the side surfaces of the opening, and is provided between the conductor and a protrudent electrode that is made of Sn or a metal having Sn as its main component. Among other things, these illustrative example embodiments can prevent deterioration of connection reliability due to gap formation in the vicinity of the protrudent electrode. Good connection reliability of the protrudent electrode is provided by using Sn or a metal having Sn as its main component, which have good wetting properties. By providing the metal layer so as to cover the upper surface portion of the conductor exposed by the opening, but not, for example, side surfaces of the opening, no gap is formed between the insulating layer and the protrudent electrode, even if metal from the metal layer diffuses into the protrudent electrode. Thus, it is possible to prevent the deterioration in reliability due to water condensation in the gap.

Claims 1-9 were rejected under 35 U.S.C. Section 103(a) as allegedly being obvious over Akram (U.S. Patent No. 5,736,456) in view of Okada *et al.* (U.S. Patent No. 6,111,317) and Andicacos *et al.* (U.S. Patent No. 5,937,320). Applicants traverse this rejection.

Akram discloses a method of forming conductive bumps on a die for flip chip applications. Akram shows a metal layer completely covering both the bottom and side surfaces of the opening formed in insulating layer 56 to expose conductive trace 54. Thus, Akram is clearly deficient with respect to the language in claim 1 calling for a metal layer covering a bottom surface, but not side surfaces, of the opening section on the main conductor layer. The

office action alleges that Okada *et al.* remedies this deficiency of Akram. Specifically, the office action contends that Figure 5 of Okada *et al.* shows “metal layers (16-1, 16-2) formed only on the bottom of the exposed portion of the metal layer.” Applicants disagree with this contention inasmuch as layers 16-1 and 16-2 are not formed only on a bottom surface of the opening section 15A of Okada *et al.* Indeed, these layers correspond to the main conductor layer of claim 1, not to the metal layer on the conductor layer. At best, Okada *et al.* might provide some teaching with respect to conductive trace 54 of Akram. However, Okada *et al.* does not disclose or suggest a metal layer covering a bottom surface, but not side surfaces, of an opening section on a main conductor and provides no teaching or suggestion to modify Akram so as to provide the subject matter of claim 1.

Andricacos *et al.* is cited simply for its teaching at col. 1, lines 62-64 of using Sn as a low-melting solder and the combination of this reference with Akram and Okada *et al.*, even if proper, would not have resulted in the subject matter of claim 1.

Claims 2-9 depend from claim 1 and likewise would not have been rendered obvious by the proposed combination of Akram, Okada *et al.* and Andricacos *et al.* These dependent claims also recite additional patentable features

Claim 10 was rejected under 35 U.S.C. Section 103(a) as allegedly being obvious over the proposed combination of Akram, Okada *et al.* and Andricacos *et al.*, in further view of Stamper *et al.* (U.S. Patent No. 6,362,531). Stamper *et al.*, for example, does not remedy the deficiencies of the proposed Akram-Okada *et al.*-Andricacos *et al.* combination with respect to claim 1. Thus, claim 10, which depends from claim 1, would not have been rendered obvious by the proposed four-way combination of Akram, Okada *et al.*, Andricacos *et al.* and Stamper *et al.*

Claims 17 and 22-24 were rejected under 35 U.S.C. Section 103(a) as allegedly being “obvious” over Akram in view of Rates (U.S. Patent No. 5,736,456) and Andricacos. With respect to independent claim 17, Akram at least fails to disclose the claimed metal layer that completely covers the upper surface portion of a wiring layer exposed by an opening in an insulating layer, but not the side surfaces of the opening. The office action purports to remedy this deficiency using Rates. Rates purports to increase the reliability of a die by reducing the potential for intermetallic reaction (purple plague) that typically takes place between an

aluminum bond pad and a gold wire. Rates also provides a conductive material such as a gold bump on an aluminum bond pad for providing a contact of similar material to a lead used in the testing and burn-in process. Figure 1 of Rates, referenced in the office action, is a cross-sectional view of a die bond pad having a field metals layer 16 affixed between a gold bump 18 and an aluminum bond pad. The field metals layer 16 is composed of a first field metal layer 20 of titanium and tungsten (Ti/W) and a second field metal layer 22 of gold, thereby preventing an intermetallic reaction that reduces die reliability. Among other things, Rates provides no motivation to modify Akram. Indeed, the assertions in the office action regarding better defining bond pad windows and sealing pin holes are attributed in the Rates specification to providing a second passivation layer 26, not to any characteristics of metal layers 16, 22. Thus, there would have been no motivation to modify the characteristics of the metal layer in Akram based on Rates. Andricacos *et al.* is again cited for its disclosure of using Sn as a low-melting solder and the combination of this reference with Akram and Rates (even if proper) would not have resulted in the subject matter of claim 17.

Claims 22-24 depend from claim 17 and likewise would not have been rendered obvious by the proposed combination of Akram, Rates and Andricacos *et al.* These dependent claims also recite additional patentable features.

Claims 18-21 (which depend from claim 17) were rejected under 35 U.S.C. Section 103(a) as allegedly being "obvious" over the proposed combination of Akram, Rates and Andricacos *et al.*, in further view of Greer (U.S. Patent No. 6,451,681). The office action alleges that Greer teaches a multi-layered conductive layer (122, 124, 200, 202). However, even assuming the barrier layer 122 and the adhesion layer 200 of Greer are alleged to correspond to the first and second metal layer of claim 18, this purported "conductive layer" of Greer is not connected to an electrode pad formed on a semiconductor substrate as claimed. As such, Greer would not have provided any teaching or suggestion to modify the conductive layer of Akram as proposed. In any event, Greer does not remedy the deficiencies of the proposed Akram-Rates-Andricacos *et al.* combination and thus even if the multi-layer conductor identified in the office action could somehow be added to the combination, the subject matter of claims 18-21 would not have resulted.

Claims 25-28 were rejected under 35 U.S.C. Section 103(a) as allegedly being "obvious" over Akram in view of Rates and Greer. The office action relies on Rates to remedy the deficiencies of Akram with respect to the claimed metal layer and further relies on Greer to remedy the deficiencies of Akram and Rates with respect to a wiring layer that comprises first, second and third metal layers. In particular, the office action alleges that layers 304, 306 and 308 correspond to the claimed first, second and third metal layers of the claimed wiring layer. For reasons similar to those set forth above with respect to the rejection of claim 17, Akram and Rates are not properly combinable to provide a metal layer as claimed in claim 17. In addition, Applicants do not believe the layers identified in Greer in the office action would have provided motivation to incorporate such layers into a device resulting from the proposed combination of Akram and Rates.

Claims 26-28 depend from claim 25 and likewise would not have been rendered obvious by the proposed combination of Akram, Rates and Greer. These dependent claims also recite additional patentable features.

New claims 29-34 have been added. The subject matter of these new claims is fully supported by the original disclosure and no new matter is added. Claims 29 and 30 depend from claim 1; claims 31 and 32 depend from claim 17; and claims 33 and 34 depend from claim 25. These new claims are believed to be allowable because of the stated dependencies and because of the additional patentable features contained therein.

Applicants submit that the pending claims are in condition for allowance, and action to that end is earnestly solicited.

ISHIO et al.
Serial No. 09/883,366

If any issues remain to be resolved, the Examiner is urged to contact the attorney for Applicants at the telephone number listed below.

Respectfully submitted,

NIXON & VANDERHYE P.C.

A handwritten signature in cursive script, appearing to read "Michael J. Shea", is written over a horizontal line.

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